



## Wind Atlas for Egypt

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## Wind Atlas for Egypt

A national database for wind resource assessment and  
wind power planning

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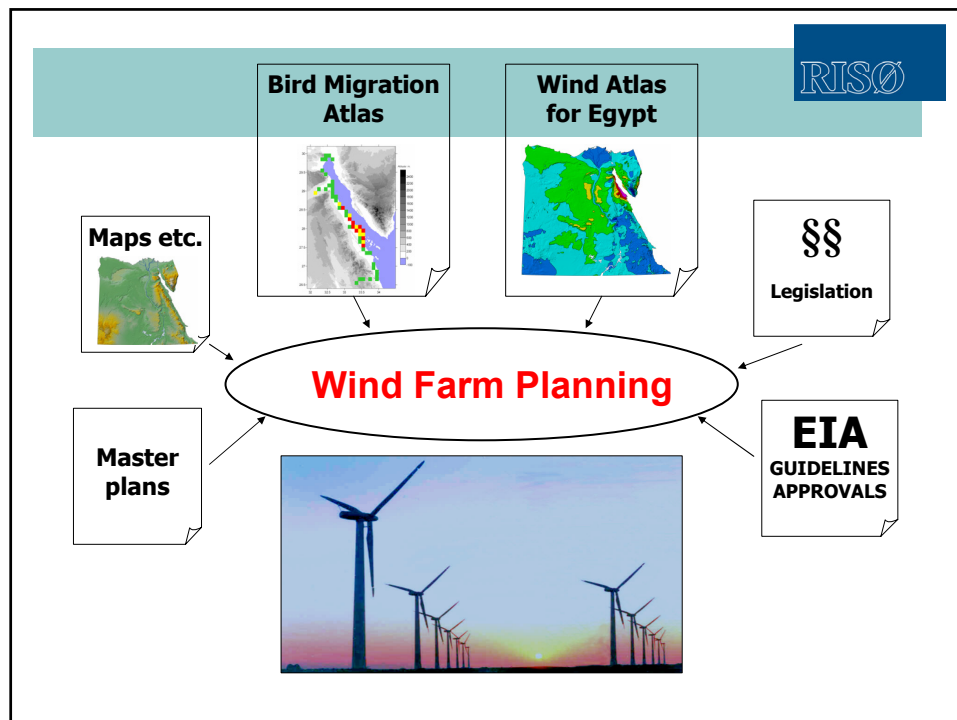
MENAREC 3, Cairo, Egypt  
12 June 2006

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## Wind Atlas for Egypt overview

- Observational wind atlas
  - meteorological measurements
  - microscale modelling (WAsP)
- Wind resource mapping
  - reanalysis wind climatologies (NCEP/NCAR)
  - mesoscale modelling (KAMM)
- Numerical wind atlas
  - verification – measurements and models
  - Wind Atlas for Egypt book and CD-ROM
- Applications and future
  - planning, feasibility studies, project preparation
  - wind farm planning and annual energy production

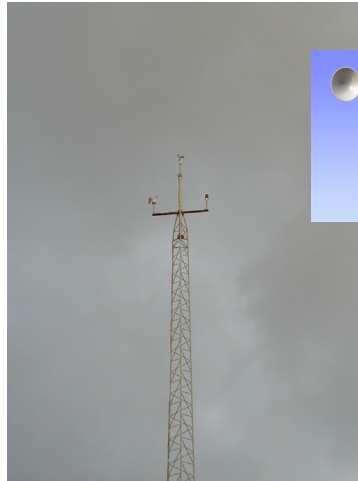
The RISO logo is in the top right corner.

## Sample meteorological mast in Zafarana

RISØ



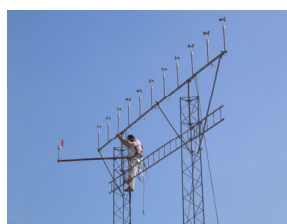
25-m lattice tower, concrete foundation



Top-pole mounting to avoid flow distortion

## Hurghada Cup Anemometer Calibration Facility

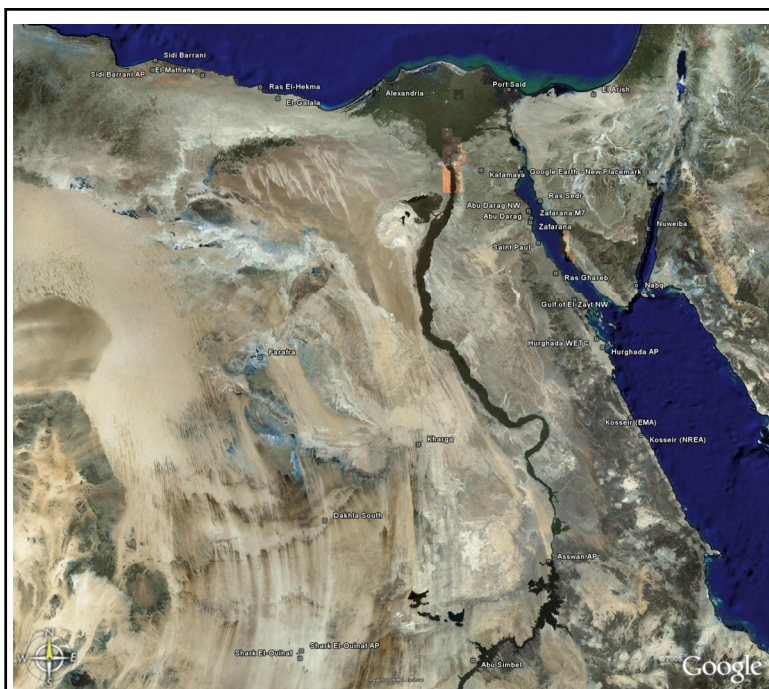
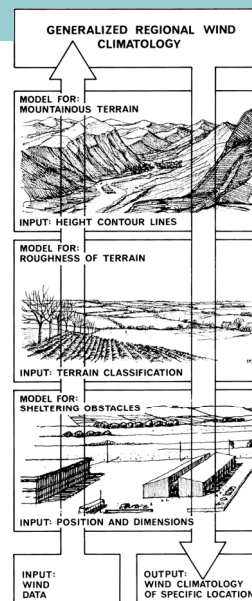
RISØ



10 anemometers being calibrated – reference anemometer in middle position: ○

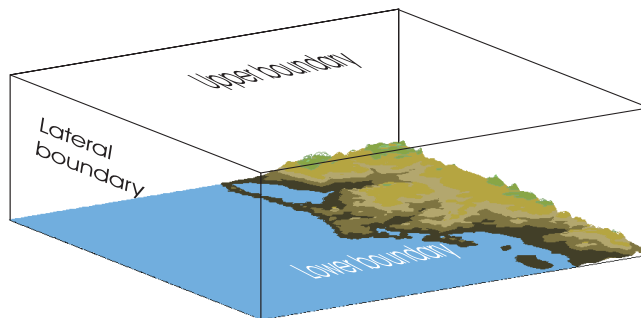
## Observational wind atlas

- Analysis procedure ↑ (WAsP)
  - Observed Wind Climate**
    - + sheltering obstacles
    - + roughness map (GE, SWBD)
    - + elevation map (SRTM 3)
  - ⇒ **Regional Wind Climate**
- Application procedure ↓ (WAsP)
  - Regional Wind Climate**
    - + sheltering obstacles
    - + roughness map
    - + elevation map
  - ⇒ **Predicted Wind Climate**
  - ⇒ **Predicted wind farm AEP**

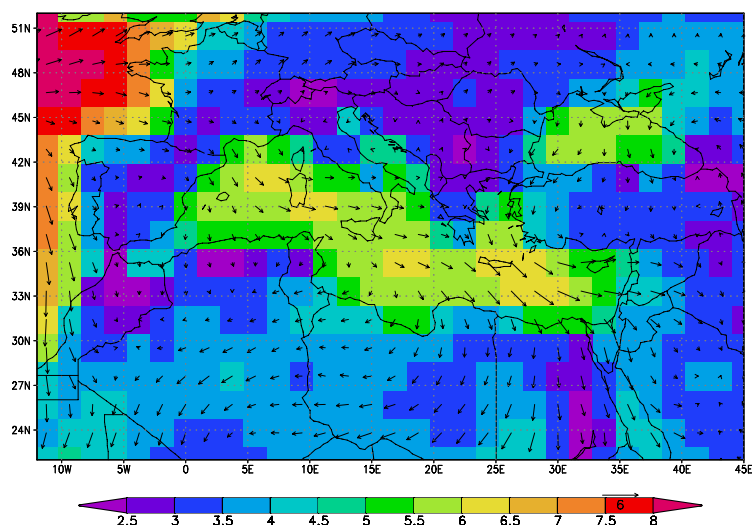


## Wind resource mapping by modelling

- Mesoscale model
- Output: annual averages of wind speed and power
- Regular horizontal grid
- Area: 10,000-100,000's of km<sup>2</sup>
- Resolution: 3-5 km
- Wind measurements are not required, but...
- Super-computer and skilled staff are needed!
- Uncertainty inherently larger than observational wind atlas

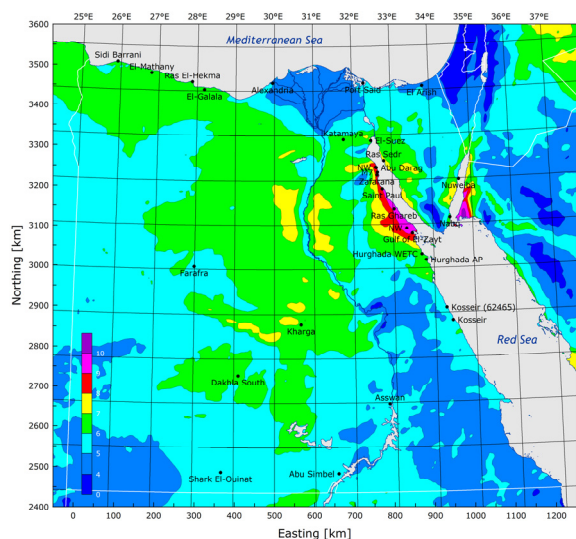


## Regional winds from NCEP/NCAR reanalysis



## New wind resource map of Egypt

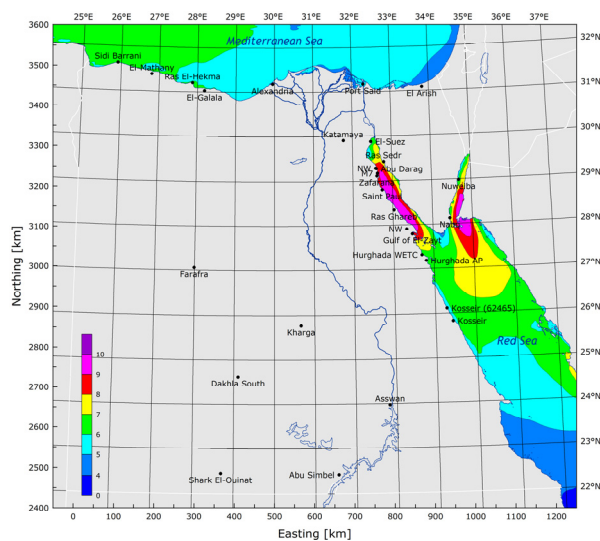
RISØ



- Map shows PWC
- KAMM modelling
- Resolution 7.5 km
- Mean wind speed 50 m a.g.l. [ $\text{ms}^{-1}$ ]
- NCEP/NCAR data
- GTOPO30 elevation
- GLCC land cover
- Terrain features may give higher wind speeds locally!
- Output formats:
  - map graphics
  - statistics

## ...and Egyptian offshore wind resources

RISØ

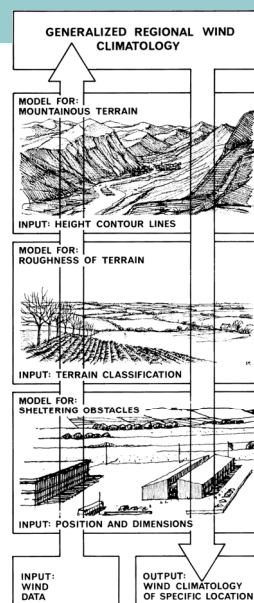


- Map shows PWC
- KAMM modelling
- Resolution 7.5 km
- Mean wind speed 50 m a.g.l. [ $\text{ms}^{-1}$ ]

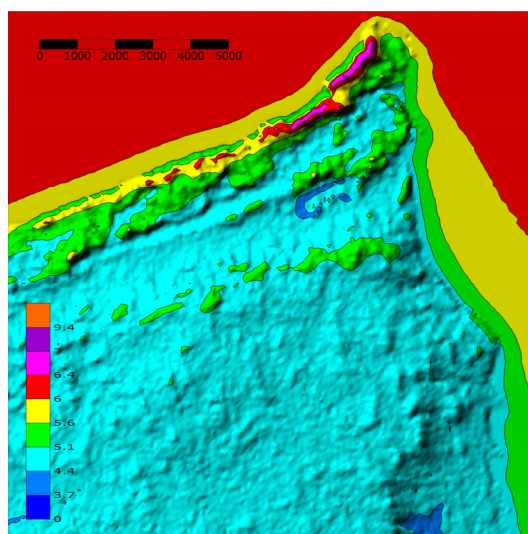


## Numerical wind atlas

- NWA analysis procedure ↑ (WAsP-like)
  - KAMM Predicted Wind Climate**
    - (> 50,000 virtual met. stations!)
    - + roughness map (GLCC)
    - + elevation map (GTOPO30)
    - ⇒ **Regional Wind Climate**
- Application procedure ↓ (WAsP)
  - Regional Wind Climate**
    - + sheltering obstacles
    - + roughness map
    - + elevation map
    - ⇒ **Predicted Wind Climate**
    - + power and thrust curves
    - ⇒ **Predicted wind farm AEP**

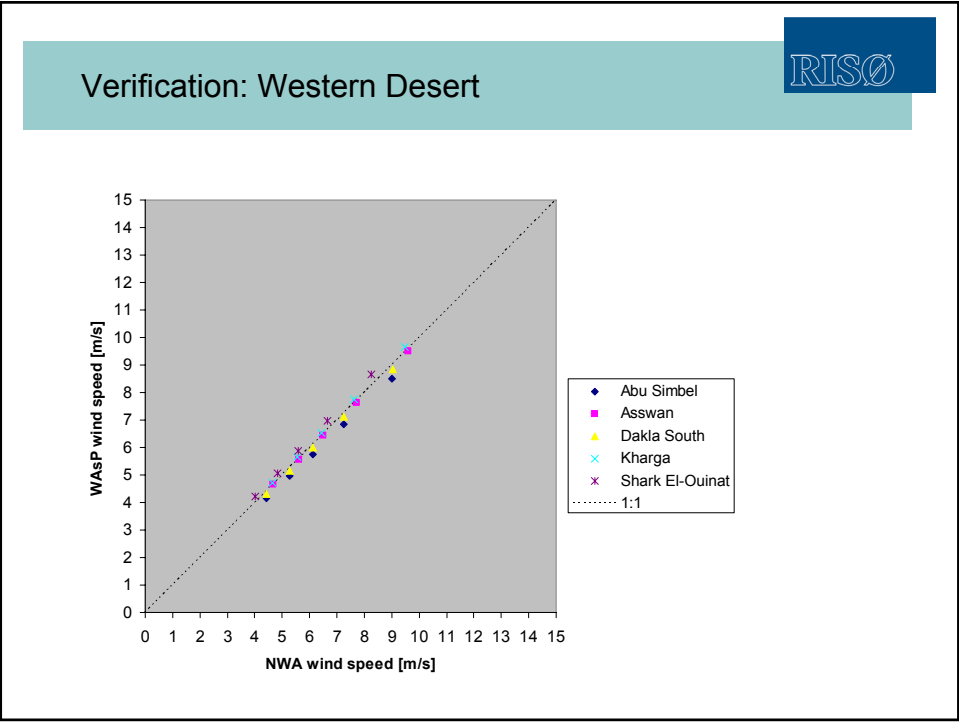
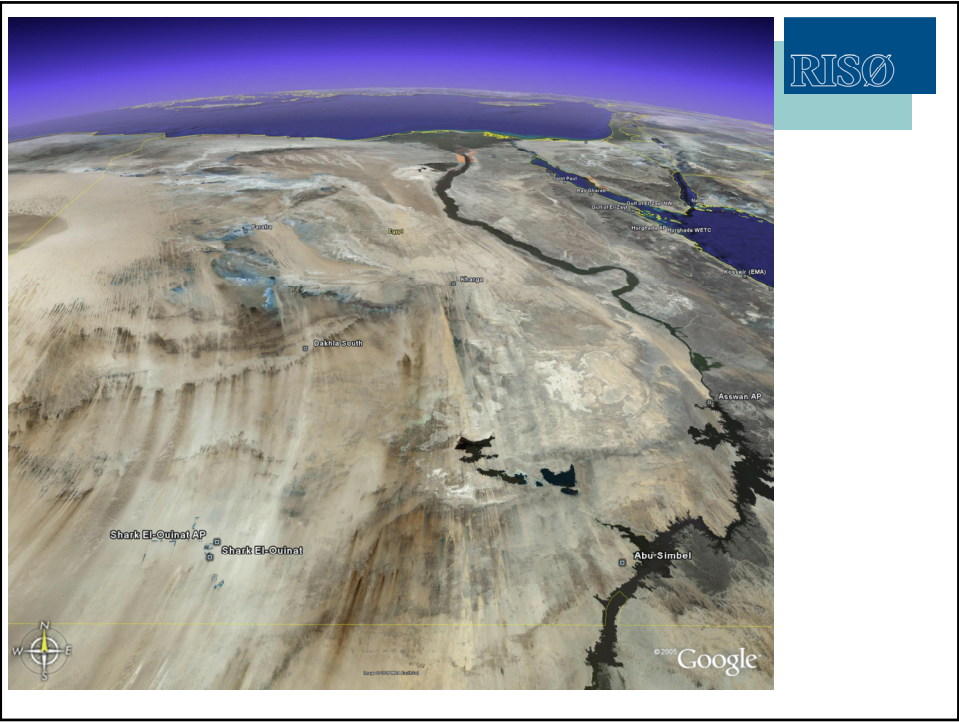


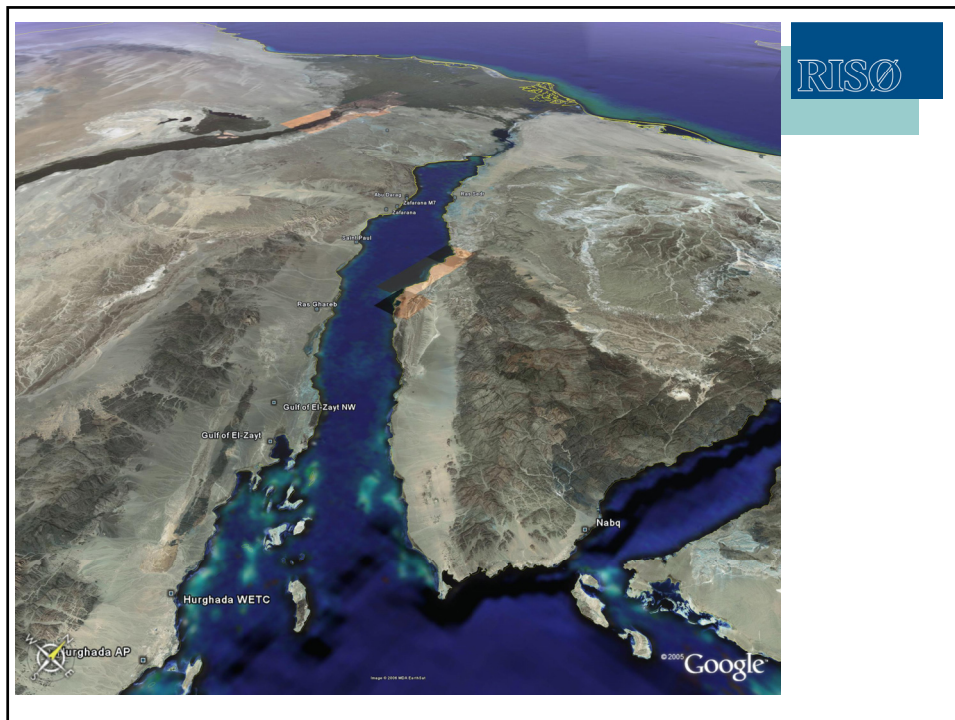
## Detailed wind resources at Ras El-Hekma



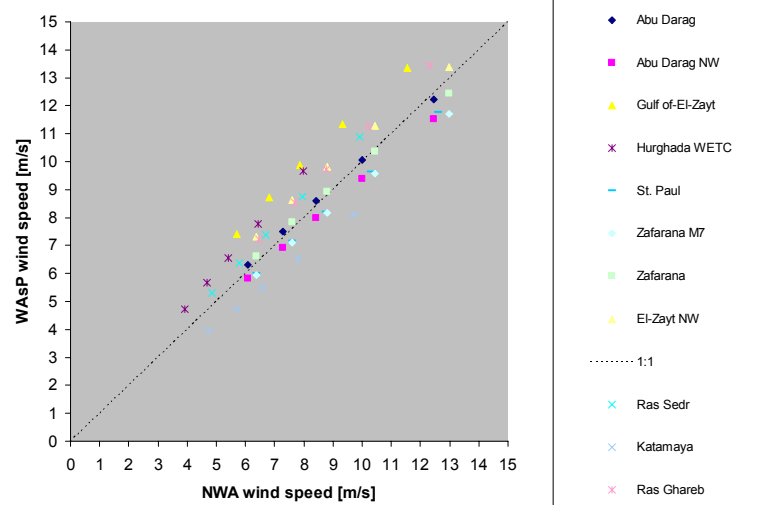
- WAsP modelling of detailed wind speed @ 10 m a.g.l.
- Resolution 100 m
- KAMM wind map indicates Class 2
- Offshore resource is higher: Class 5
- Coastal resource is higher: Class 3/4
- Hill/ridge resource is higher: Class 6







## Verification – Gulf of Suez

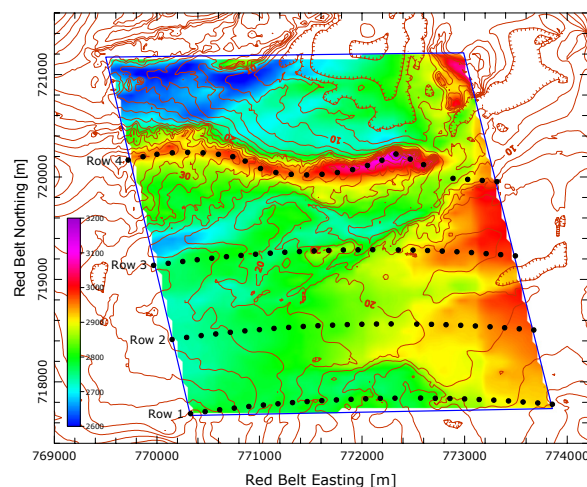


## Wind Atlas for Egypt – application range



1. Egyptian wind resources on national scale
  - Input: numerical wind atlas database (large domains)
  - Output: resource maps, statistics, GIS data,...
  - Purpose: national planning, decision making, master plans,...
2. Regional resource assessments and wind power planning
  - Input: numerical wind atlas database (regional domains)
  - Output: as 1. + predicted wind climates, power productions,...
  - Purpose: regional planning, feasibility studies,...
3. Local resource assessments and wind farm planning
  - Input: observational wind atlas data
  - Output: as 1. + predicted wind climates, power productions,...
  - Purpose: planning, feasibility studies, project preparation,...
  - Bankable resource assessments close to met. stations

## Detailed wind resources at Zafarana



## A complete package...



- Wind-climatological inputs
  - Observational wind atlas (30+ stations)
  - Numerical wind atlas (all of Egypt)
- Topographical inputs covering all of Egypt
  - SRTM 3" elevation data
  - SRTM Water Body Data (coasts and lakes)
  - Google Earth satellite imagery (land-use)
- Software tools
  - Microscale modelling tools (WAsP software)
  - Terrain mapping tools (Surfer, Map Editor, Didger)
- Other resources
  - Wind atlases, wind farm planning report, capacity building, ...
  - Bird Migration Atlas, EIA reports, guidelines, ...

## The future...



- Numerical wind atlas (KAMM/WAsP methodology)
  - Long-term data (1968-95) – infrequent updating ok
- Observational wind atlas
  - Some reference met. stations should continue
  - New measurement programmes may be initiated
  - Cup anemometers must be rehabilitated and recalibrated
  - Wind Atlas for Egypt can be updated, extended and detailed
- Main conclusions
  - wind resource assessment, siting and wind farm planning can now be done within hours anywhere in Egypt
  - present approach to wind resource assessment and siting in Egypt may be continued for several years
  - numerical wind atlas methodology can be applied elsewhere

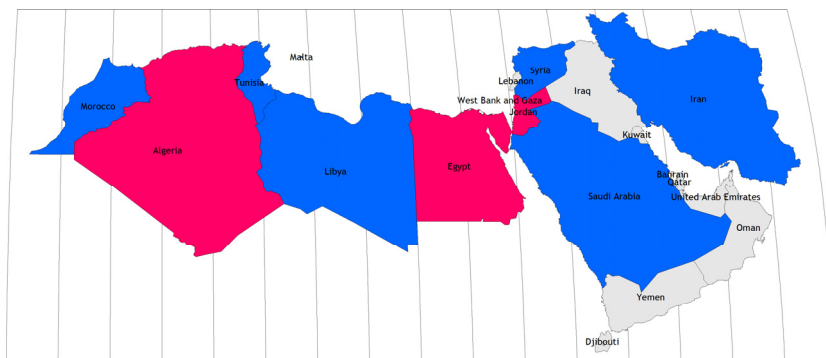
# THE END

Thank you for your attention! ☺



(slide by Magnus, 10 years old)

## MENA Region overview



- 3 countries with national wind atlases: Algeria, Egypt and Jordan
- 7 countries with some wind resource assessment and siting activities
- 10 countries where no information was available (to me at least)
- if you have any other or more information I'd like to know...